Showcase Demonstration

CASE STUDY

a Program of the U.S. Department of Energy

THE CHALLENGE: IMPROVING VENTILATION SYSTEM PERFORMANCE AT A METAL PLATING FACILITY

Summary

Lockheed Martin Armament Systems was looking for a way to improve the performance of the ventilation system in their Lakeside Avenue industrial plating plant in Burlington, Vermont. By utilizing variable frequency drives (VFDs) and making other modifications to the system, they were able to improve the plant's overall operating efficiency, reduce costs, and improve the work environment and worker health and safety. This Motor Challenge Showcase Demonstration Project has resulted in annual savings of more than $68,000, with a payback of just under one and a half years.

Project Profile	
Industry:	Fabricated Metal Product
Process:	Metal Plating and Finishing
System:	Ventilation Fan
Technology:	VFD Retrofit

Plant Overview

The Lockheed Martin Vermont facility, classified as Small Arms (SIC 3484), primarily manufactures armament systems as well as munitions, fire control systems, and advanced weapon systems sold domestically and to U.S. allies abroad. The Lakeside Avenue plant is headquarters for Lockheed Martin Armament Systems, Lockheed Martin Ordinance Systems, and accommodates the engineering and administrative staffs and a 470,000-square-foot plant dedicated to machining and assembly operations. The plating plant is a small facility attached to the main plant.

Project Background

Concerned with rising overhead rates, Lockheed Martin management targeted energy expenditures as a prime opportunity for cost savings. At the Burlington facility, electrical costs are more than 10 cents per kWh, the highest of any Lockheed Martin plant in the country. The company had considered installing a cogeneration system to supply the plant with electricity and thermal energy, but the payback was calculated to be more than six years. Instead, the company decided to undertake a variety of projects to improve the performance and efficiency of their plant systems. They began by specifying energy-efficient motors and retrofitting their lighting systems with energy-efficient tubes and ballasts. With these projects completed, they targeted the plating operation ventilation system as their next opportunity.

Lockheed Martin Armament Systems Headquarters

The energy savings network

Plug into it!

Project Team

To implement this complicated project most efficiently, Lockheed Martin put together a project team. This team involved not only Lockheed Martin personnel, but staff from other organizations including: Burlington Electric (electric metering), GE Motors and Industrial Systems (adjustable speed drives), Johnson Controls (energy management system), the U.S. Department of Energy's (DOE) Motor Challenge (energy savings validation), electrical and mechanical engineering firms and contractors, and motor system equipment manufacturers and distributors.

LOCKHEED MARTIN

SIC: 3484

Products: Armament systems, munitions, weapons, and fire control systems

Location: Burlington, Vermont

Employees: 740

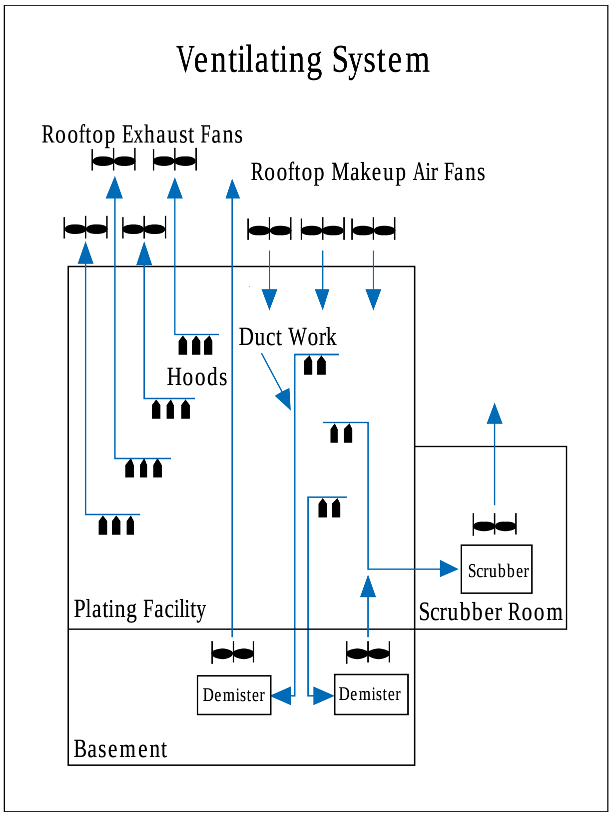
Showcase Team Leader: Phil Mix

Company Energy Philosophy: Continue to be a leader in operating a competitive, energy efficient, environmentally compliant facility utilizing the best practices for a safe workplace.

The Old System

A wide variety of small and large machined metal parts — from small firing pins to 12-foot-long gun barrels — are plated, anodized, finished, and cleaned at the facility. The plant consists of nine plating production lines with 64 tanks handling 19 different plating processes. The existing ventilation system, which has been in use for more than 25 years, was designed for continuous 24-hour operation. Currently, however, the plant is only operating one shift per day. In addition, current production patterns sometimes require a different combination of tanks to be used on any given day.

The constant volume ventilation system provides exhaust for lateral hoods over the plating dip tanks, and prevents toxic fumes from escaping from the tanks into the workers' area. It draws air into the hoods through a series of interconnecting ducts and forces the air outside. To meet EPA Title V Clean Air Act requirements, the exhaust air may pass through a demister and/or filter or scrubber before exiting the system, depending on the chemicals in the airstream. Makeup air is provided by rooftop ventilating units that use direct-fired gas heaters to maintain building temperature. The system has 10 motors ranging in size from 5 to 100 horsepower.

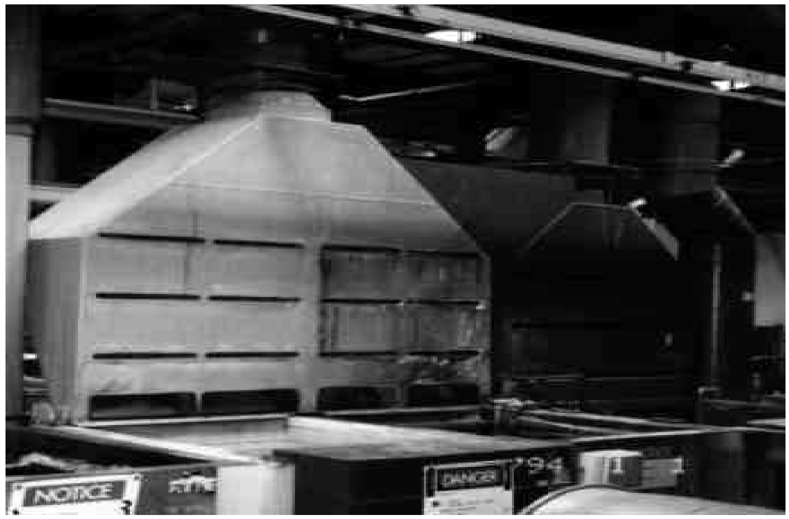


The system had undergone detailed review and numerous modifications and upgrades over the past few years. These included a motor survey, airflow measurements, hood modifications, the addition of side shields to eliminate cross drafts, increasing duct size, and balancing the system to optimize the draw at each hood.

Alternatives Considered

Plant staff considered a number of alternatives to further improve system performance, including the use of floating balls to reduce emissions and therefore the need for ventilation. This proved to be impractical, however, because many of the parts being plated have complex shapes and others are dipped using baskets. The balls became stuck in the parts and the baskets. Covers for the dip tanks were also considered, but they proved difficult to use. Other options included the use of two-speed motors and variable sheaves. The two-speed motors did not offer enough flexibility, and maintenance requirements on the variable sheaves were too high due to the location of the fans. The best solution proved to be the addition of variable frequency drives, which permit variable-speed control of the motors driving the ventilation fans. This allows the ventilation supplied by the fans to be matched to needed levels at any given time automatically.

Project Implementation — The Systems Approach



Plating Tank and Hood

One of the keys to implementing the project was the determination of relevant industrial ventilation safety standards, which allow for tanks to be “reclassified” when not in use. This means that when a tank is idle, the liquid temperature inside can be decreased and the ventilation supplied to the tank can be substantially reduced. The requirements for each tank were examined individually to the OSHA/ACGIH ventilation requirements, since ventilation needs are largely determined by the type of chemical in the tank.

During the installation of the VFDs, Lockheed Martin also decided to install a new energy management system (EMS) in conjunction with the VFDs. This was done so that the motors could be controlled as a system. The EMS also allows a trending capability and has the capacity to control the entire facility.

The New System

The new variable-output ventilation system includes nine electronic VFDs which reduce ventilation during idle times. VFD line reactors have been installed along with the drives, and the entire system is controlled by the new EMS. Flow has been reduced to 55-65 percent of full speed during idle times. The system also features manual safety overrides and a failure analysis system with an automatic shutoff. Numerous sensors and control points have been added to better monitor and control the system.

Results

The plating tanks are monitored for operating temperature to control the exhaust and air makeup units. During working hours and off-shift hours the EMS detects unused plating lines and reduces the exhaust and makeup air supply.

Benefits of the new system include a 38 percent cost reduction in electric and natural gas utilities, emergency ventilation control, fewer emissions, and improved system control. The project cost approximately $99,400 to

How VFDs Improve Performance

Most motor systems are designed to meet maximum demand. In many cases, however, actual demand varies and the system frequently operates at less than design capacity. Traditionally, these conditions are accommodated through the use of throttling valves or outlet dampers to reduce system output. While these devices reduce system output, the amount of energy used does not always decrease in proportion to the reduced output. VFDs allow the speed of a motor to be adjusted to match load requirements. Because energy use on many centrifugal systems like pumps, fans, and compressors is approximately proportional to the cube of the flow rate, small reductions in flow that are proportional to motor speed can yield large energy savings. As a result, if the system demands a reduction in flow of 20 percent, energy requirements are reduced by almost 50 percent.

VFDs are not only used to increase system energy efficiency, but also to improve process control. They can improve overall productivity, control, and product quality while reducing wear on equipment and lowering maintenance costs.

implement and has resulted in annual savings of more than $68,000, providing a simple payback of just under 1.5 years. Key to this low payback is the dramatic reduction in VFD costs over the last few years.

Lessons Learned

In addition to the economic and operational benefits of the project, a number of lessons were learned that can be applied to similar projects: (1) the EMS is essential for balancing air flows and pressures for safe operation and as a diagnostic tool for troubleshooting; (2) line reactors may be necessary before and after the drives to reduce noise and improve motor life; and (3) connecting VFDs to rewound motors may cause premature motor failure due to excessive VFD voltage spikes and noise levels. Replacement of motors with high efficiency or inverter-rated motors, or utilizing higher voltage-rated wiring from the VFD to the motor should be considered.

Performance Improvement Summary		
Annual Energy and Cost Savings		
Electricity	443,332 kWh	$35,700
Natural Gas	17,840 therms	$26,500
EMS Maintenance Contract		$ 5,800
TOTAL		$68,000
Total Annual Emissions Reductions		
CO_2	470,600 lbs	
Carbon Equivalent	128,350 lbs	
SO_x	1,400 lbs	
NO_x	890 lbs	
TSP	140 lbs	
VOC	30 lbs	
CO	190 lbs	

Other Applications

The technology used for this project can be applied to any ventilation or fan system requiring variable output to meet changing demands. Other possible fan applications include climate control systems, laboratory ventilation systems, and draft fans used for boilers and furnaces. VFDs can also be used to improve performance on other systems like blowers, pumps, compressors, grinders, mills, and conveyors. Estimates show that use of VFDs nationwide could result in energy savings of up to 99 billion kWh.

About Motor Challenge

The Motor Challenge is a joint effort by the U.S. Department of Energy (DOE), industry, motor systems equipment manufacturers and distributors, and other key stakeholders to put information about energy-efficient electric motor system technology in the hands of people who can use it.

Showcase Demonstration Projects target electric motor-driven system efficiency and productivity opportunities in specific industrial applications. They show that efficiency potential can be realized in a cost-effective manner and encourage replication at other facilities.

DOE provided technical assistance and independent performance validation (IPV) of energy savings. A DOE-sponsored IPV team reviewed the test plan and provided assistance, as requested by the host site, on testing procedures, instrumentation techniques, and data acquisition. The DOE team developed a detailed IPV Report thoroughly documenting the project. The Report is available by calling the number listed below. DOE did not witness the actual test data, and the conclusions in this case study are based solely on data provided by the host site and their partners.

For more information on becoming involved in the Motor Challenge or sponsoring a Showcase Demonstration, call the Motor Challenge Information Clearinghouse at (800) 862-2086.

Contact:
Motor Challenge Information
Clearinghouse (800) 862-2086

August 1996

ORNL/MC–CS1

Printed with a renewable source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste